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we should eventually accomplish our object of exterminating the rat. Moreover, during the time of a plague epidemic, the trouble involved in rat examinations should be lessened. If from time to time we isolate and keep under observation the cats that have been feeding upon rats, not only do we obviate any fear of spreading the infection but at the same time we have a means of determining the exact extent of the spread of the disease.

Since a multitude of artificial devices of human contrivance are not equal in efficiency to one of nature's methods in destroying rats during antipest campaigns, the most efficacious means of accomplishing our object is the utilization of the cat.

Beginning with such places as Osaka and Kobe, where plague infection constantly lies dormant, the encouragement of the breeding of cats with a view to demurization is the urgent duty of the present hour.

UNITED STATES.

[Reports to the Surgeon-General, Public Health and Marine-Hospital Service.]

PLAGUE IN GROUND SQUIRRELS.

In a communication dated August 28, 1908, Passed Assistant Surgeon Blue, San Francisco, Cal., transmits a full bacteriological report by Passed Assistant Surgeon McCoy on the plague-infected ground squirrel found on the Farias ranch in the northern part of Contra Costa County, August 5, 1908. A case of human plague occurred on this ranch July 11, 1908. [See Public Health Reports, July 31, 1908, page 1096.]

Doctor Blue observes that this is perhaps the first demonstration of the occurrence in nature of bubonic plague in the ground squirrel (*Citellus beecheyi*) of California. There can be no further doubt, therefore, he writes, that these rodents are an important factor in the dissemination of infection.

Practically the same findings have been obtained by Acting Assistant Surgeon Wherry in the Oakland laboratory, and are reported under date of August 24, 1908.

The following is the report, dated August 27, 1908, of Passed Assistant Surgeon McCoy on the examination of the tissue from the squirrel suspected of being infected with plague:

EXAMINATION OF TISSUE.

The tissue presented for investigation was a piece of the lung of the squirrel. It was received on August 6, 1908. Smear preparations from this tissue, made as soon as received and stained with 1 per cent carbol-thionin, showed the presence of an organism that was morphologically as follows:

Short rods varying in length from 1 to 2 micra and in width from one-half to three-fourths of a micron, and staining most intensely at the ends. Circular bodies about three-fourths of a micron in diameter and staining rather faintly except at the rim. Forms intermediate between the two described. None of the organisms retained the stain when treated by Gram's method.

CULTURES.

Stroke cultures were made directly on agar. A pure culture of an organism that grew in the form of small, round, moist, shining colonies, which when touched with the needle were found to be viscid, was obtained upon this medium. Stained films from this growth showed the organism to be a bacillus, averaging a trifle smaller than the first form described above. The staining was for the most part uniform throughout, but a few elements showed deeper staining at the ends. The organism was nonmotile, and special staining failed to show any spores. Heating a 4-day-old broth culture to 60° C. for five minutes was sufficient to kill the organism. At room temperature (about 17° C.) the growth was less vigorous than at 35° C.

From the original agar culture inoculations were made upon other media with the following results:

Broth.—In twenty-four hours a very fine granular precipitate was formed, and a few islands of growth were present upon the surface. The medium remained clear. After several days, a rather thick layer of feathery growth occurred in the upper layer of the medium. When the tube was shaken the growth fell to the bottom in globular masses. Stained film preparations showed an organism agreeing in appearance with the one grown upon agar, but always staining uniformly throughout. Many chains of from 2 to 10 or 15 elements were found.

Salt agar.—Upon agar made with 3 per cent chemically pure sodium chloride, the growth was rather scanty, and stained films made at the end of twenty hours showed a large variety of forms, none of which bore any resemblance to the organism planted. There were present spherical forms up to 5 micra in diameter, sausage-shaped forms from 3 to 6 micra in length and about one-fourth as broad as long, hour-glass shaped forms, and globular forms with a long filament. The length of one of the latter forms was found to be 26 micra. There were other forms similar to those described above, but smaller.

Litmus milk.—This medium was unchanged throughout the period of observation (seven days).

Gelatin.—Not liquefied (fourteen days). Small whitish granular colonies along line of inoculation.

Glucose broth.—No gas; slight acidity in four days.

Lactose broth.—No gas; no acidity in four days.

The medium used in all of the work was +1 (acid) to phenolphthalein.

ANIMAL INOCULATIONS.

Some of the tissue was rubbed into the shaven skin of the belly of a guinea pig (vaccination). After forty-eight hours a large, brawny swelling was present at the sight of vaccination, and the inguinal lymphatic glands were much enlarged. The animal died on the fourth day. At the site of the vaccination was a scab that had at its edges the appearance of a row of dried vesicles. There was a subcutaneous œdema. Both chains of inguinal glands were enlarged and surrounded by a considerable hemorrhagic area. The glands felt firm, but upon section were found to be caseous. The spleen was 2½ by 1 by ½ cm. in size, friable, light red, and contained many fine whitish granules. The liver had many fine whitish granules. A bipolar bacillus was found in smears from the liver and the spleen. Cultures were made from the liver. An organism was recovered that gave characteristic growths on broth and agar, and upon salt agar gave characteristic involution forms in twenty-four hours.

A small piece of the tissue was placed beneath the skin of the belly wall of another guinea pig. The animal died in twenty-four hours from pneumonia, which was at this time destroying a considerable number of our guinea pigs.

We had no white rats in stock at the time the specimen was received, so that we were compelled to resort to the use of wild rats. Plague work with wild rats is unsatisfactory for two reasons: First, when more than one is kept in a cage, as was necessary on account of the limited space available, the ones that succumb first are very apt to be partly devoured by their comrades, and thus render a satisfactory post-mortem examination impossible. Second, a certain percentage of the wild Mus norvegicus in San Francisco are immune to plague. This has been demonstrated by work that will form the subject of a later report.

Our rats are kept in quarantine a week to obviate the possibility of any being used that are incubating plague or are suffering from the disease.

Two rats (small *Mus norvegicus*) had small pieces of the lung introduced beneath the skin of the belly wall.

One was found dead on the second day (forty-eight hours). It had been partly eaten, but an examination was made. A marked general injection was found. There was a bubo in the right inguinal region and a typical granular plague liver. Many bipolar bacilli were found in the bubo and in the liver. Cultures were not made. One was found dead on the third day, but it had been so badly mutilated by its companion that no satisfactory examination was practicable.

One small *Mus norvegicus* was "vaccinated" with the squirrel's lung. This rat was killed on the fifth day. The autopsy was negative beyond showing an enlarged axillary gland that had several yellowish points resembling those seen in rats that have been inoculated with plague, but are recovering. No organisms were found in smears. Cultures were not made.

It will be observed that one of these rats presented lesions that would justify a diagnosis of plague. One was probably resistent. The other could not be examined.

It may be stated here that under the conditions surrounding this experiment, there is practically no natural or accidental mortality in rats, so that it is fair to assume that the death of the rat that could not be examined was the result of the inoculation.

A culture of the organism is fully virulent for rats, and gives rise to characteristic lesions of plague in these animals, as is shown by the following experiments:

Three *Mus rattus* were inoculated, each one with 0.01 of a loopful of a 72-hour-old agar culture (second generation). The culture was one isolated directly from the squirrel's lung. Two of the rats died on the third day and one on the fourth day. All showed quite sufficient lesions of plague for a diagnosis, based upon the gross signs alone. In addition, all showed typical organisms in smears. Cultures were made from one of these, and a pure culture of *Bacillus pestis* obtained. No cultures were made from the others.

Three half-grown *Mus norvegicus* were inoculated at the same time with the same culture and with the same amount used for the *Mus rattus*. One died on the fourth day, one on the fifth day, and one on the sixth day. The gross findings were characteristic of plague in each case. Characteristic organisms were found in smears and isolated in culture directly from two of them. The third (dead on the sixth day) failed to show any organisms in smears. A guinea pig was vaccinated with tissues from this rat. The guinea pig died with typical lesions of plague on the fourth day and a pure culture of *Bacillus pestis* was isolated from the liver.

While no doubt was entertained as to the nature of the organism under investigation, it seemed desirable to test it against antipest serum. For this purpose we used guinea pigs and rats (*Mus norvegicus*). The culture was the same as in the above experiment, but was the third generation, and the growth was 48 hours old. In each case the animal was given subcutaneously 0.01 of a loopful of the agar culture. Three guinea pigs were used. The first guinea pig was given 5 cc. of antipest serum intraperitoneally just prior to the inoculation. This animal never sickened, and is alive and well at the present time, 10 days after the inoculation.

The second guinea pig was given 5 cc. of antidiphtheria serum intraperitoneally just prior to inoculation. This was done to provide a serum control. This animal died on the fourth day with characteristic lesions of plague, and cultures from the liver gave a pure culture of *Bacillus pestis.*

The third guinea pig was inoculated with the culture in the same manner as the previous ones, but no serum was given; therefore it served as a control. This guinea pig died on the fourth day and presented lesions characteristic of plague. An organism agreeing with the one isolated directly from the squirrel was obtained in pure culture from its liver.

Four rats (*Mus norvegicus*) were inoculated with the same amount of the same culture as was given to the guinea pigs. Two of the rats that had previously been given 5 cc. of antipest serum were killed on the eighth day and were shown by post-mortem examination to be normal. The two that had not received serum (controls) died on the fourth day, and both presented typical lesions of plague as seen in rats, and a pure culture of *Bacillus pestis* was isolated from the liver in each case.

In order to determine whether the organism was as virulent as the *Bacillus pestis* isolated from rats here two series of guinea pigs were inoculated, with the results shown in the table below. An agar culture was used in each case.

Quantity of culture.	Guinea pig died.	
	Squirrel (second generation).	Rat No. 66 (fourth generation).
1 loopful, vaccinated	Fourth day	Fifth day.
0.01 loopful, inoculated subcutaneously	Fifth day	Third day.
0.001 loopful, inoculated subcutaneously	do	Seventh day.
0.0001 loopful, inoculated subcutaneously	Eighth day	Sixth day.
0.00001 loopful, inoculated subcutaneously	Fifth day	Seventh day.
0.000001 loopful, inoculated subcutaneously	Seventh day	Sixteenth day.

The control was *Bacillus pestis*, isolated from plague rat No. 66. Neither of these cultures had ever been through an animal other than the ones in which they were found in nature. It will be observed that there is no material difference in the virulence of the cultures.

The only organism with which it is necessary to contrast the one under consideration is *Bacillus pseudotuberculosis rodentium* (Pfeiffer). We have not had an opportunity of working with this organism, but judged by MacConkey's work (Journal of Hygiene, Vol. 8, No. 3, June, 1908), this organism is morphologically and culturally almost identical with *Bacillus pestis*, the difference being only that *Bacillus pseudotuberculosis rodentium* makes litmus milk alkaline and its growth upon agar is not viscid. *Bacillus pseudotuberculosis rodentium* gives involution forms on salt agar. The lesions observed in guinea pigs resemble those of plague, and it was even possible to produce immunization to *Bacillus pestis* by inoculations with *Bacillus pseudotuberculosis rodentium*. This organism, however, is not acutely pathogenic for rats. This appears to be the crucial point of difference.

The result of this examination establishes beyond any question the fact that this squirrel was infected with a virulent strain of *Bacillus pestis*.

Reports from Los Angeles, Cal.—A case of plague.

In a telegram of August 20 and a letter of August 24 Surgeon Brooks, Los Angeles, reports a boy bitten in the finger by a ground squirrel on August 5 or 6, sickened August 11, was seen by a physician August 12, and was reported to the local health officer in Los Angeles as suspicious. The boy resided at Buena Vista Park. Though the squirrel was destroyed by a dog and a cat August 21, a search of the premises nearby resulted in the discovery of another dead squirrel. The boy is recovering. September 3, information was received by wire from Passed Assistant Surgeon Blue, San Francisco, that material taken from one of the buboes in the boy presented bacteriological evidence of plague. September 4, he further reported that the squirrel above referred to found dead in the park at Los Angeles also presented positive evidence of plague. Surgeon Brooks reports that the boy is isolated and the city officials have taken decisive action. By request of the secretary of the State board of health and of the local authorities, an expert bacteriologist of the Public Health and Marine-Hospital Service has been assigned to duty at Los Angeles.

Reports from San Francisco, Cal.—Plague-prevention work.

Passed Assistant Surgeon Blue reports:

SAN FRANCISCO, CAL.

Week ended August 29.

Date of last case	Sickened, January 30, 1908
Sick inspected	10
Dead inspected	120
Premises inspected	14,446
Houses disinfected	262
Houses destroyed	9
Buildings condemned	9
Nuisances abated	1,801
Rats found dead	458
Rats trapped	4,301
Total rats taken	4,759
Rats identified:	
Mus norvegicus	3,478
Mus rattus	81
Mus musculus	1,165
Total	4,724
Poisons placed	143,084